SLAC Program Update

By Jonathan Dorfan, Director

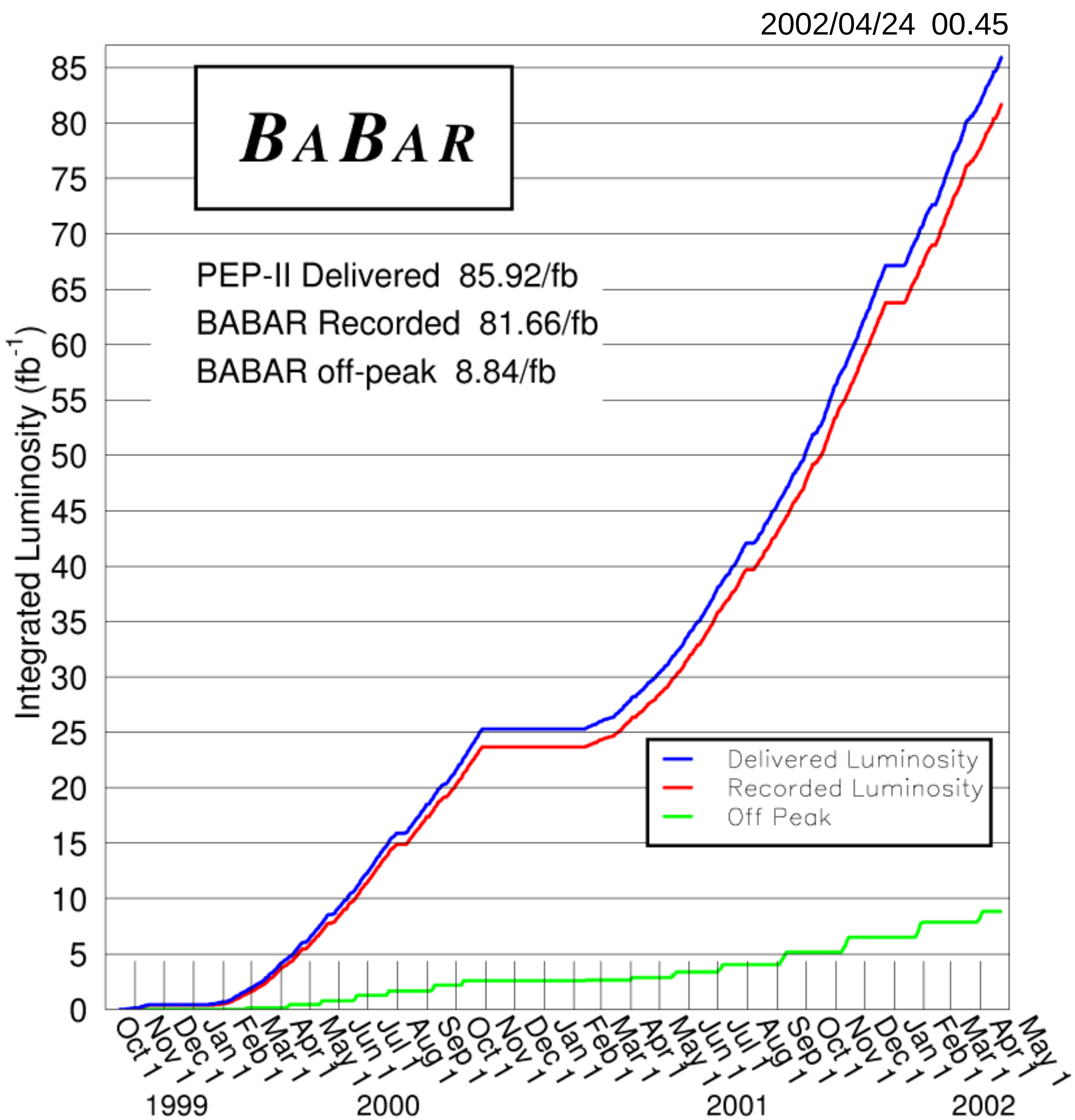
FNAL HEPAP Meeting

April 26-27, 2002

B Factory – Performance and Upgrades

- Run continues to go well. On track for 100 fb^{-1} by time of shutdown at the end of June 2002
- Running will commence mid-November, 2002 after considerable downtime activities
- Upgrade of facility continues – PEP-II will have installed capability of 10^{34} cm^{-2} sec^{-1} following this Summer's down
- Another round of RF/Vacuum improvements will be installed in Summer 2004 providing a capability of $2x10^{34}$ cm^{-2} sec^{-1}
- Anticipate > 600 fb^{-1} by 2006

Integrated Luminosity



BABAR Physics

BABAR continues to publish at an impressive rate. 25 papers are now published or submitted for publications

- ✓ **13 papers accepted/published in Physical Review Letters**
- ✓ **3 more submitted for publication in Physical Review Letters**
- ✓ **7 papers published in Physical Review D**
- ✓ **1 more paper submitted to Physical Review D**
- ✓ **1 paper published in NIM**

Main *CP* results were updated for Winter conferences

sin2b = 0.75 ± 0.09 ± 0.04 (based on 57 *f*b^{-1})

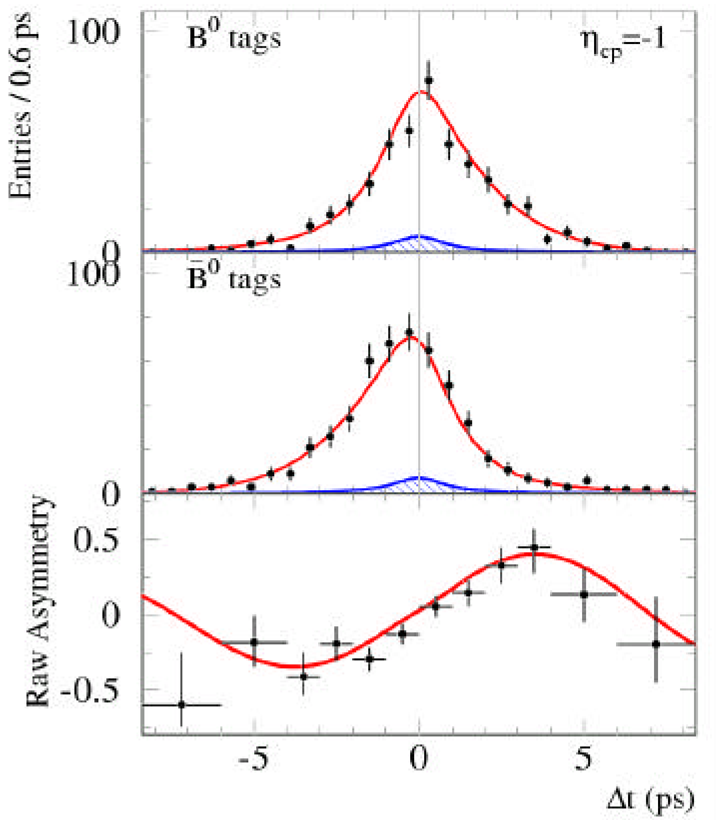
From B ® p^{+} p^{-}

S = - 0.01 ± 0.37 ± 0.07

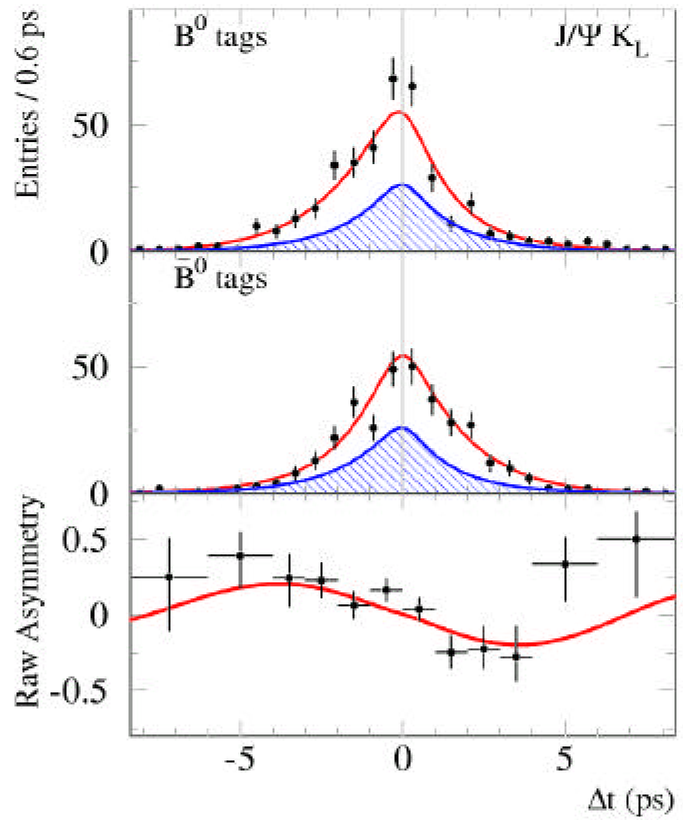
C = - 0.02 ± 0.29 ± 0.07

CP asymmetry in *CP* –1 and +1 modes

$(c\bar{c})\ K_s$ CP = -1

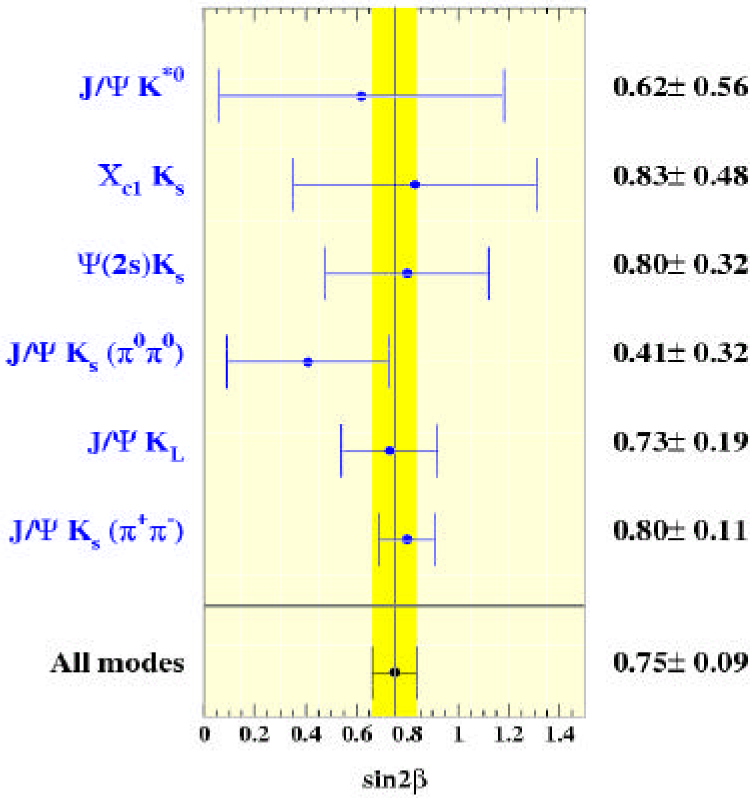


$J/\Psi\ K_L$ CP = +1

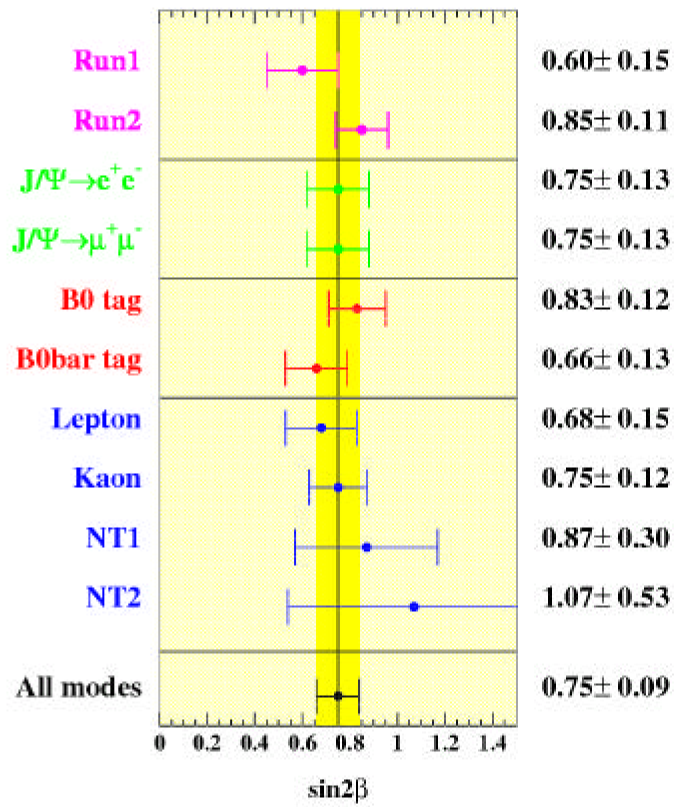


sin2b = 0.75 ± 0.09 (stat) ± 0.04 (sys)

sin2β by decay mode

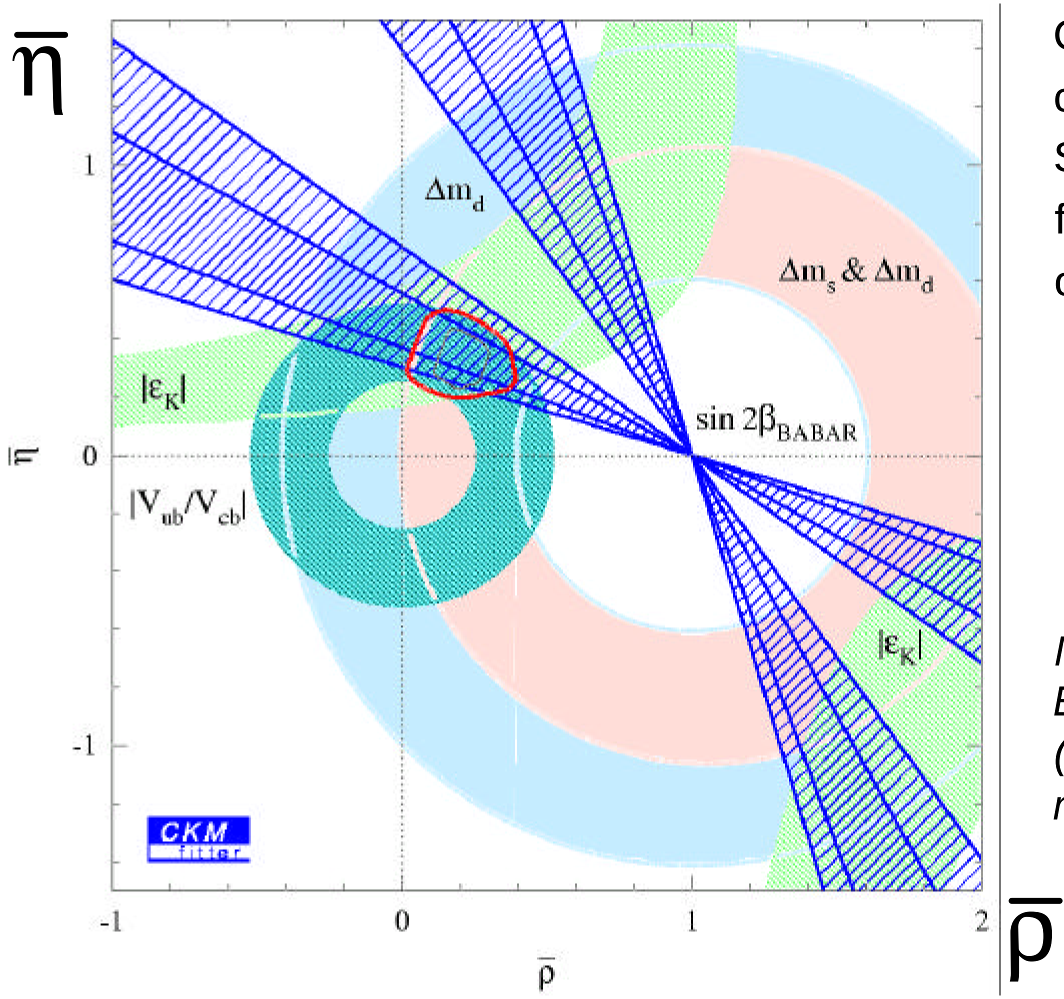


sin2β in sub-samples



Individual modes and sub-samples are all consistent.

CKM Interpretation



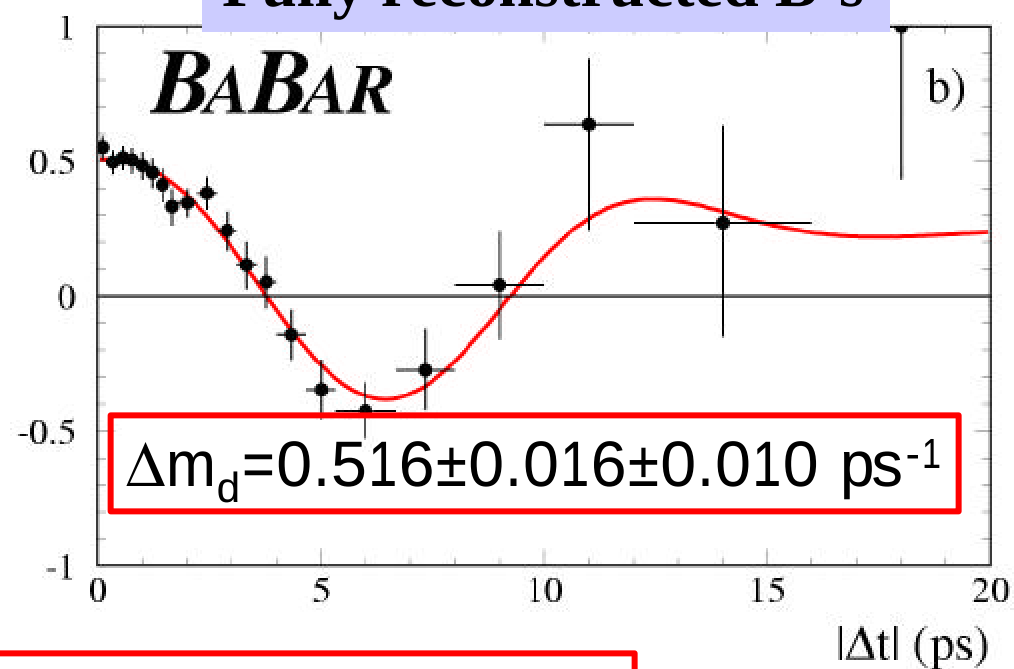
Our sin2β measurement is consistent with current Standard Model constraints from measurements of other parameters.

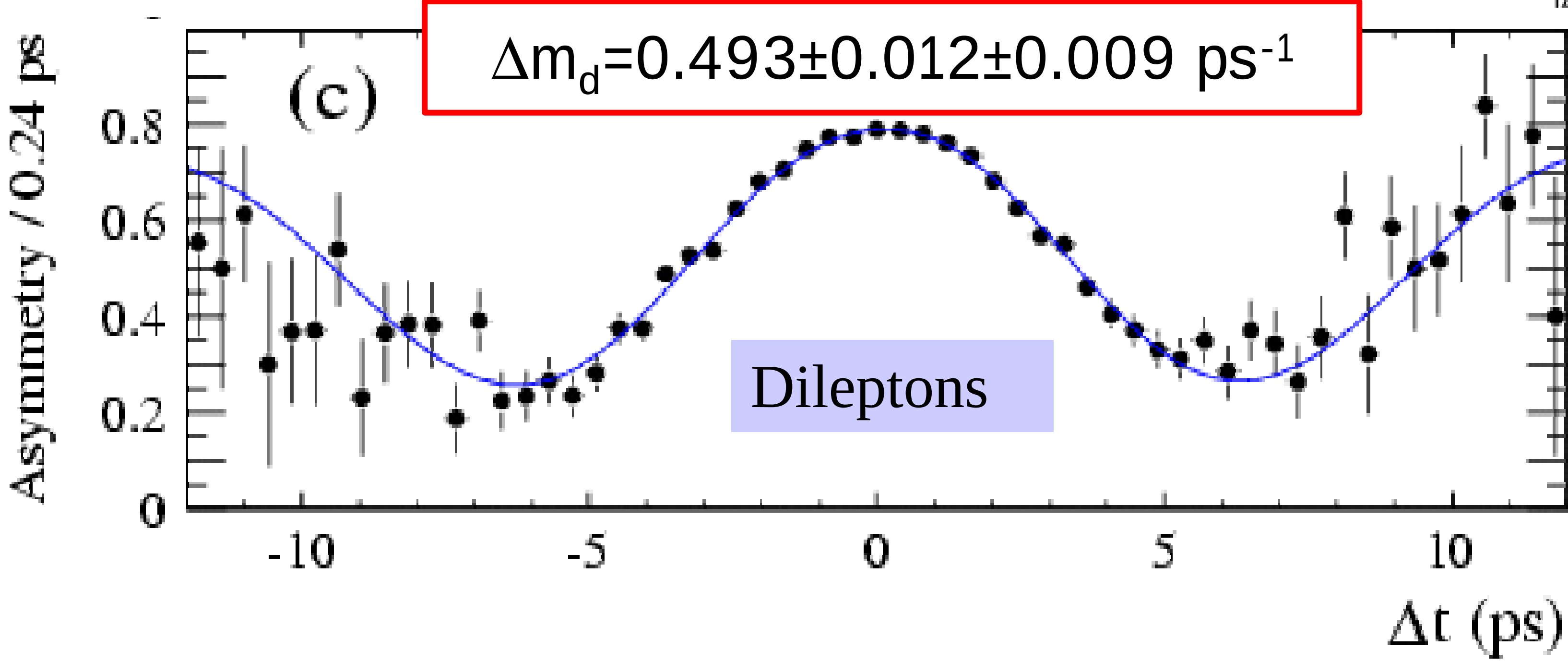
$\bar{\rho} = \rho(1-\lambda^2/2)$
$\bar{\eta} = \eta(1-\lambda^2/2)$

Method as in Höcker et al, Eur.Phys.J.C21:225-259,2001 (also other recent global CKM matrix analyses)

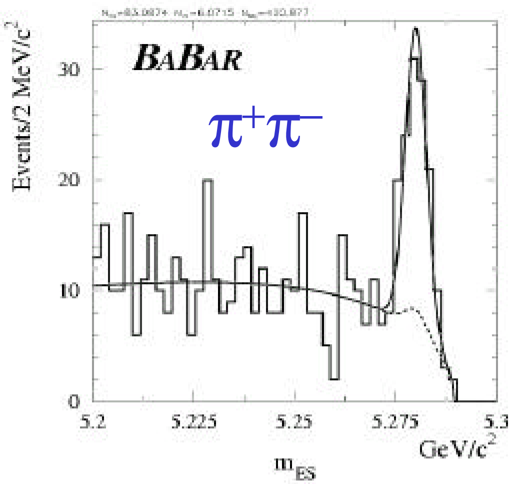
$B^0 \Leftrightarrow \overline{B}^0$ Oscillations

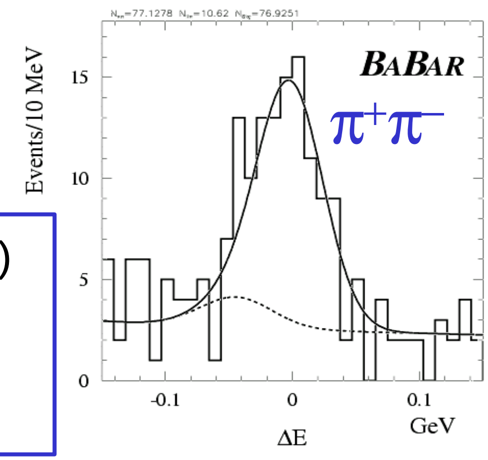
Fully reconstructed B's





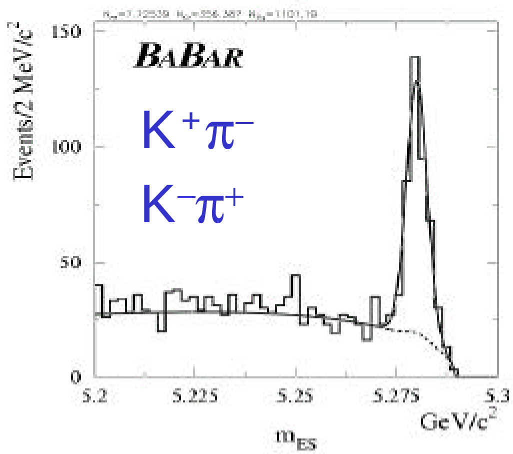
Branching Fractions and CP Asymmetries in $B \to \pi^+\pi^-$ and $B \to K^+\pi^-$ modes





Branching fractions
in units of x 10^{-6}

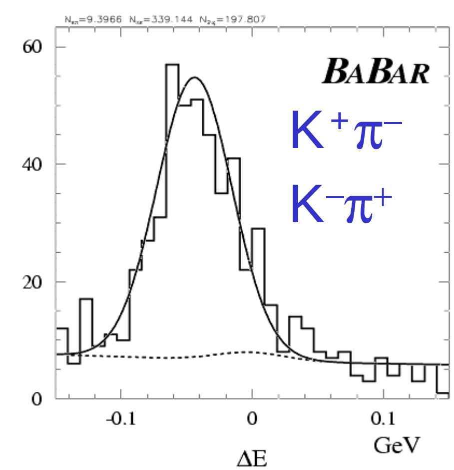
$B(p^+p^-)$ = (5.4 ± 0.7 ± 0.04)
$B(K^+p^-)$ = (17.8 ± 1.1 ± 0.8)
$B(K^+K^-)$ < (1.1 , 90% C.L.)



Direct CP asymmetry

$$\boxed{A_{K\pi} \equiv \frac{N_{K^-\pi^+} - N_{K^+\pi^-}}{N_{K^-\pi^+} + N_{K^+\pi^-}}}$$

A_{Kp} = -0.05 ± 0.06 ± 0.01



m_{es}

ΔE

Likelihood projections

Mixing and Lifetime measurements with rare decays

- Measure B lifetime using $B^0 \rightarrow p^+ p^- / K^{\pm} p^{\mp}$

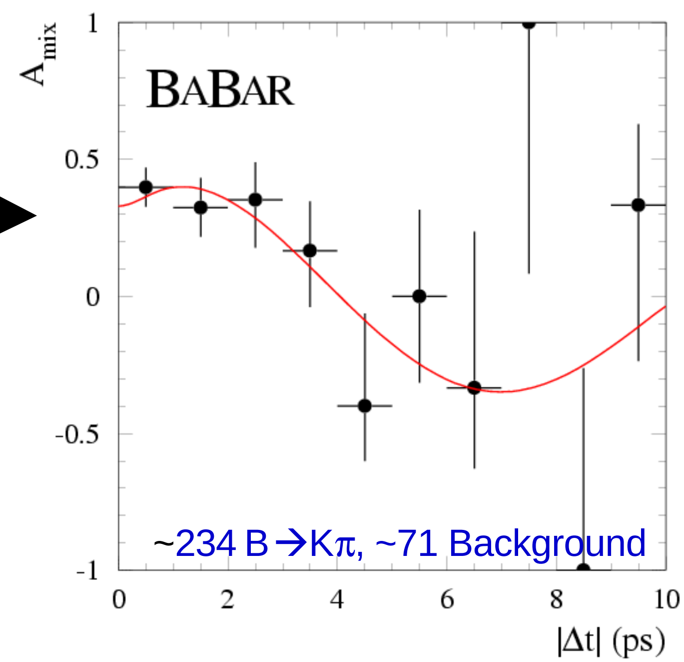
$$\Rightarrow t = 1.66 \pm 0.09\ \mathrm{ps}$$

Cross-check

- Measure Δm_d using $B^0 \rightarrow K^+ p^-$

$$\Rightarrow \Delta m_d = 0.517 \pm 0.062\ \mathrm{ps}^{-1}$$

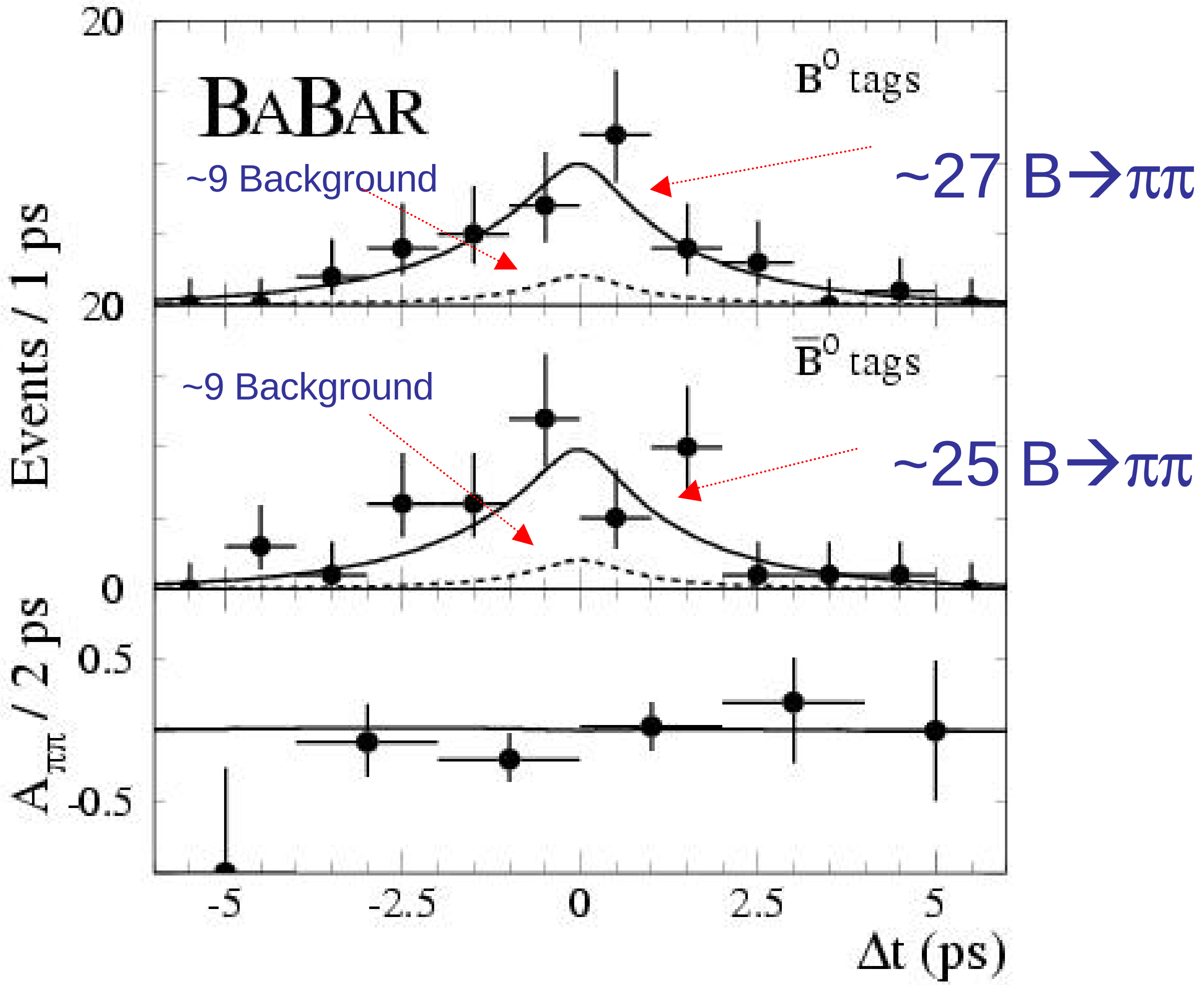
Select B→Kπ sample and plot the asymmetry between mixed/unmixed events.



$$\boxed{A_{cp,f}(t) = S_f \ \sin\Delta m\Delta t - C_f \ \cos\Delta m\Delta t}$$

$$S_{\pi\pi} = -0.01 \pm 0.37 \pm 0.07 \ [-0.66,+0.62]$$
$$C_{\pi\pi} = -0.02 \pm 0.29 \pm 0.07 \ [-0.54,+0.48]$$

90% CL



Select B→ππ sample and plot the asymmetry between mixed/unmixed events.

•**Starting to explore other (non-charmonium) modes such as B® D*D*, more to come!**

CP asymmetry in b→ccd decays: $D^{*\pm}D^{*+}$ and $D^{*\pm}D^{+}$

$$A_{cp,f}(t) = S_f \ \sin \Delta m \Delta t - C_f \ \cos \Delta m \Delta t$$

D^*D^*

$S = -0.05 \pm 0.45 \pm 0.05$

$C = 0.12 \pm 0.30 \pm 0.05$

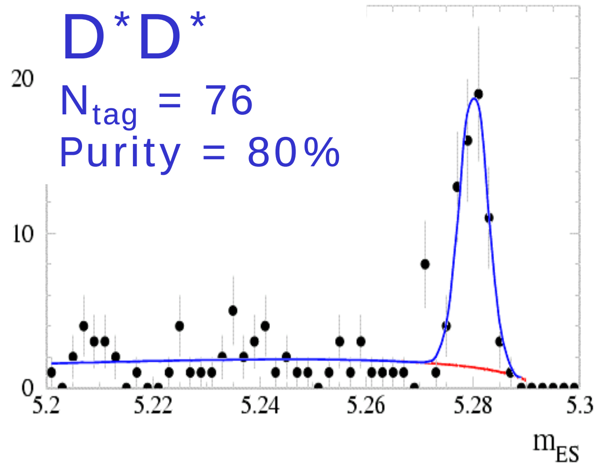
D^*D

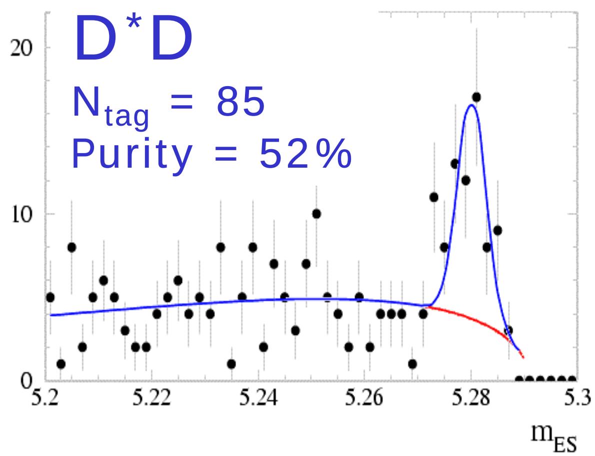
$S_{+-} = -0.43 \pm 1.41 \pm 0.20$

$C_{+-} = 0.53 \pm 0.74 \pm 0.13$

$S_{-+} = 0.38 \pm 0.88 \pm 0.05$

$C_{-+} = 0.30 \pm 0.50 \pm 0.08$





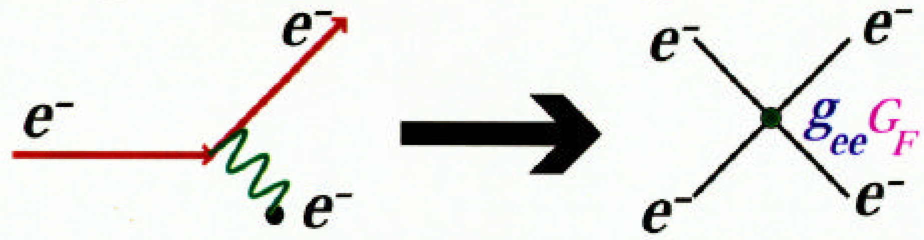
Next step: angular analysis for D^*D^*

E158 – Möller Scattering in End Station A

- **Experiment has just begun production running at 120Hz**
  - **Has achieved the very impressive beam stability and background rejection performance needed to make this 0.2 ppm asymmetry measurement**
- **E158 will run through May 2002 and return for its final 3 month run in FY2003**

SLAC E158 in End Station A

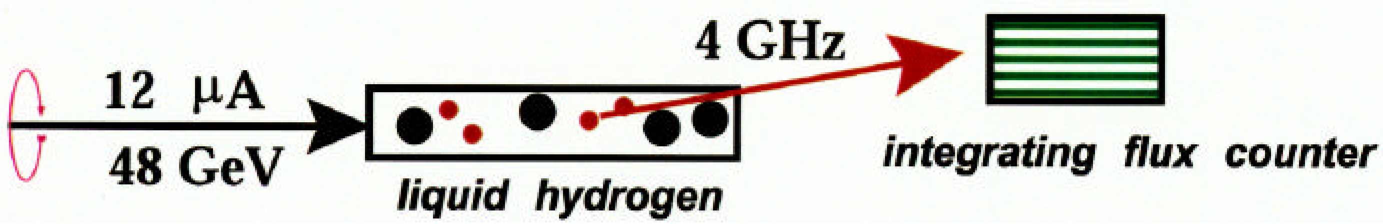
Left-Right Asymmetry in Fixed Target Moller Scattering

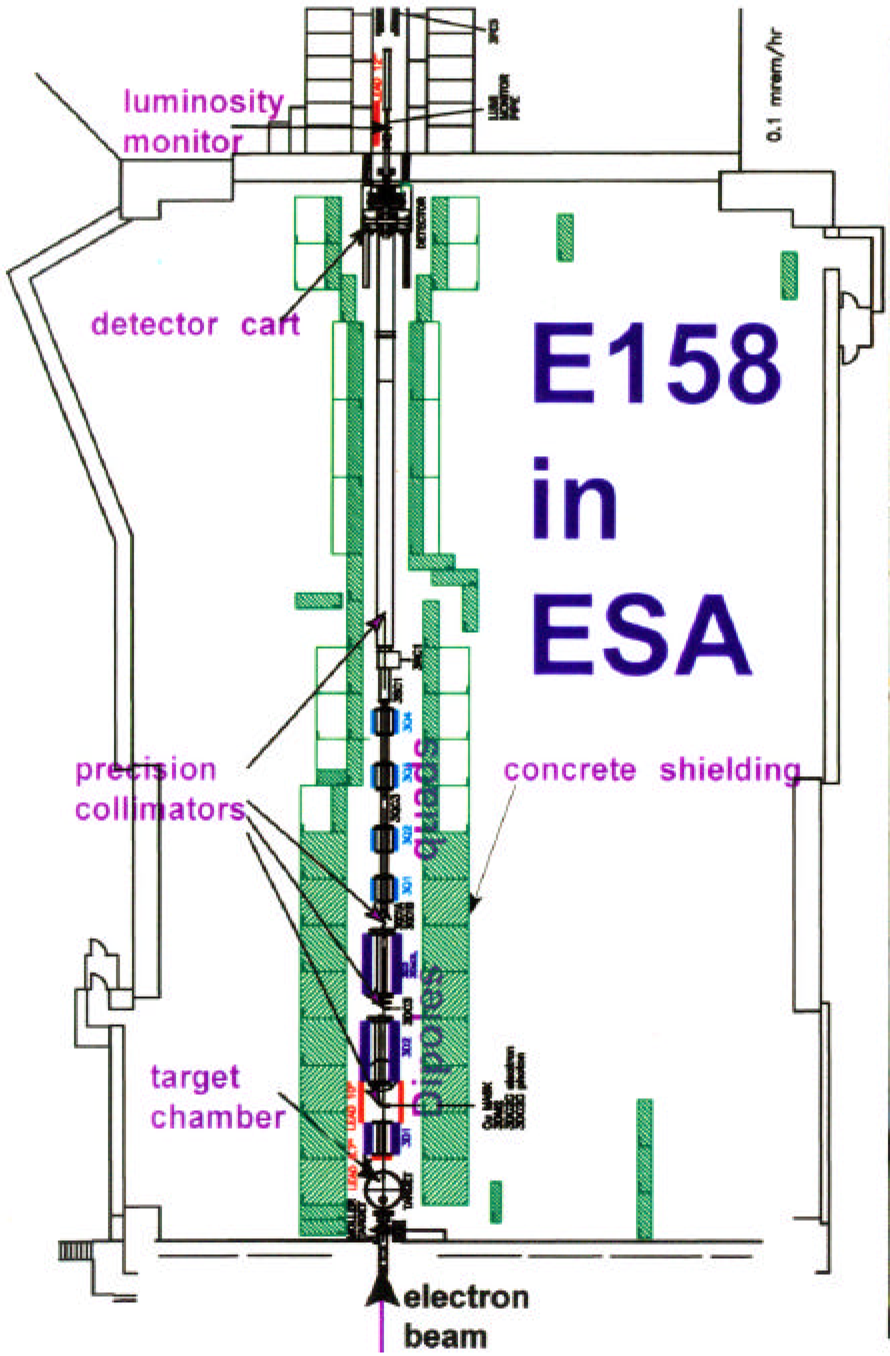


Goal: Most precise $sin^2\theta_W$ away from the Z pole

$$A_{LR} = \frac{\sigma_\uparrow - \sigma_\downarrow}{\sigma_\uparrow + \sigma_\downarrow} = \frac{A_Z}{A_\gamma} = 0.18 \text{ parts per million (ppm)}$$

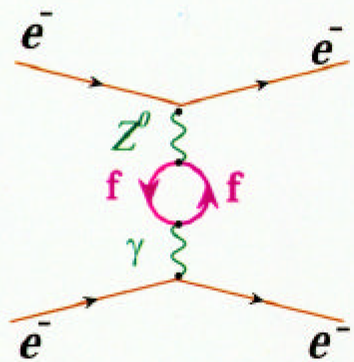
$$\delta(A_{LR}) = +/- 7\% +/- 3\%$$




luminosity monitor
detector cart
E158
in
ESA
precision collimators
concrete shielding
target chamber
electron beam
dipoles
0.1 mrem/hr

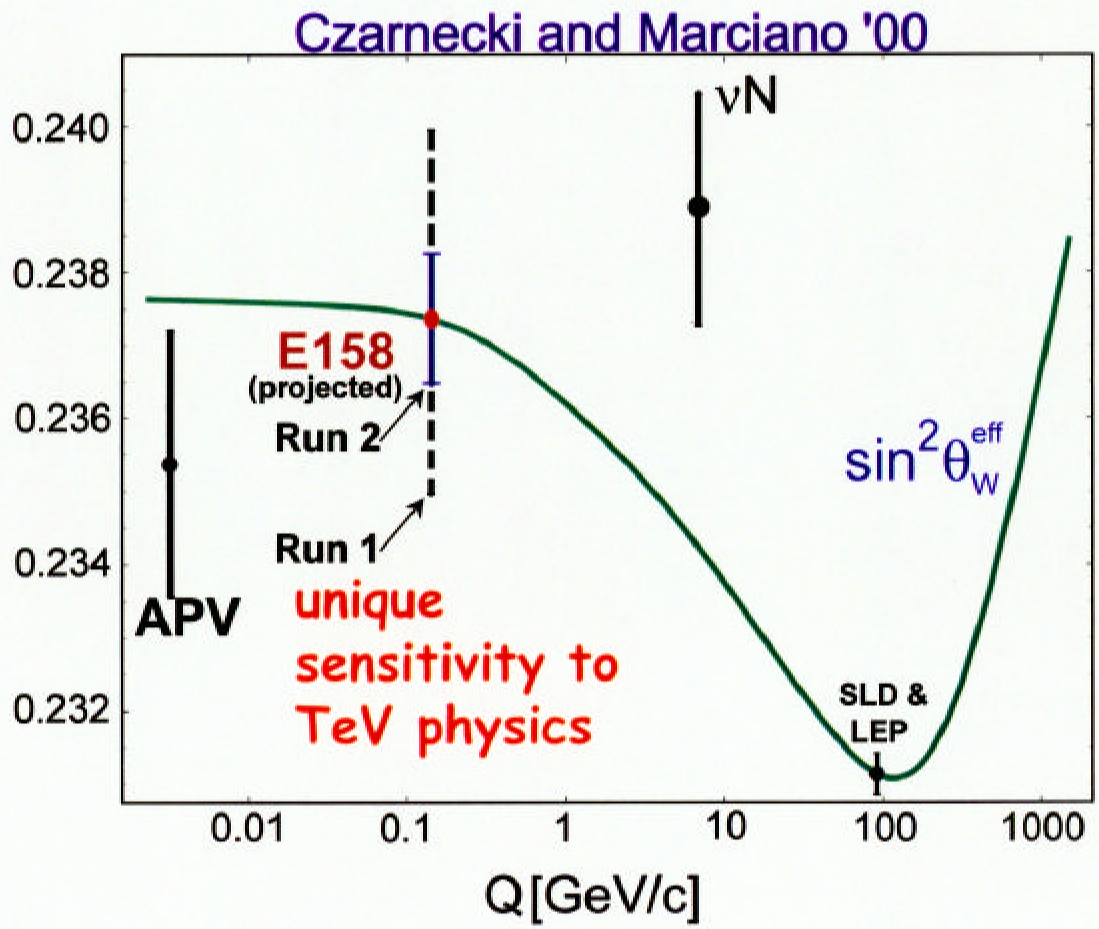
The Weak Mixing Angle at Low Q

- Unique Low Energy Leptonic Reaction
- $A_{LR} \alpha$ (1 - 4 $sin^2\theta_W$) : Added Senstivity

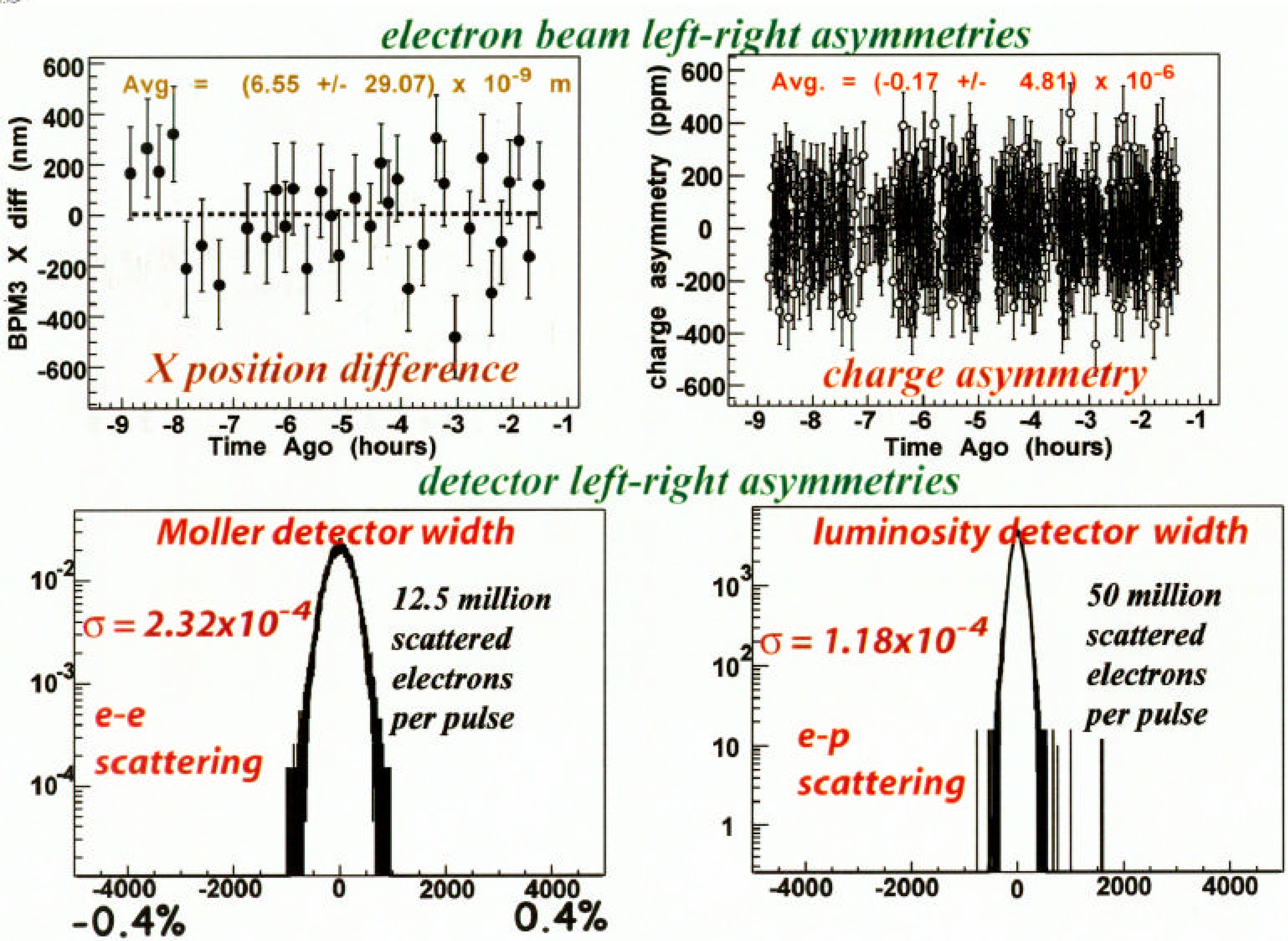


A_{tree} = 0.32 ppm

$A_{1\text{-}loop}$ = 0.18 ppm



E158 Physics Data



GLAST

- Experiment has made good technical progress
  - Highly successful balloon flight of prototype module
  - Final prototype hardware being produced for testing
  - Clean-room and assembly infrastructure in place at SLAC
- International agreements finally secure — SLAC is moving fast to implement an International Finance Committee ala BABAR
- Cost and schedule baseline not yet finalized — Lehman review this Summer aimed at completing the baseline process

GLAST LAT Overview: Design

Si Tracker

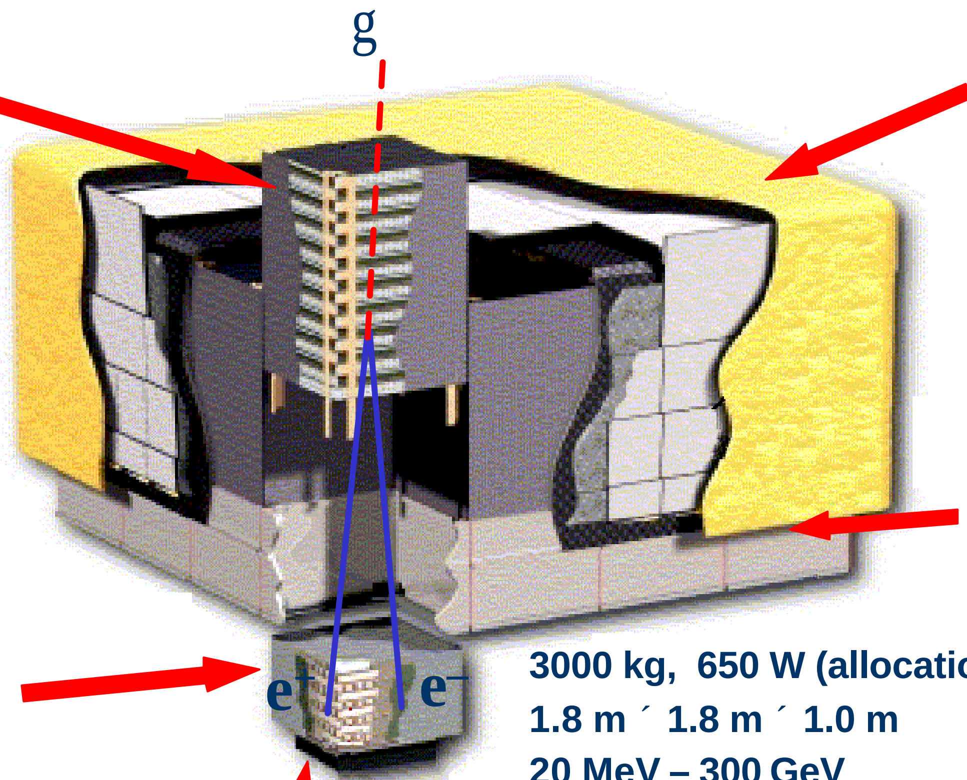
pitch = 228 µm

8.8 10⁵ channels

12 layers × 2.8% X_0

+ 4 layers × 18% X_0

+ 2 layers



ACD

Segmented scintillator tiles

0.9997 efficiency

Þ minimize self-veto

Grid (& Thermal Radiators)

CsI Calorimeter

Hodoscopic array

8.4 X_0 8 × 12 bars

2.0 × 2.7 × 33.6 cm

⇒ cosmic-ray rejection

⇒ shower leakage correction

Data acquisition

3000 kg, 650 W (allocation)

1.8 m ´ 1.8 m ´ 1.0 m

20 MeV – 300 GeV

Flight Hardware & Spares

16 Tracker Flight Modules + 2 spares

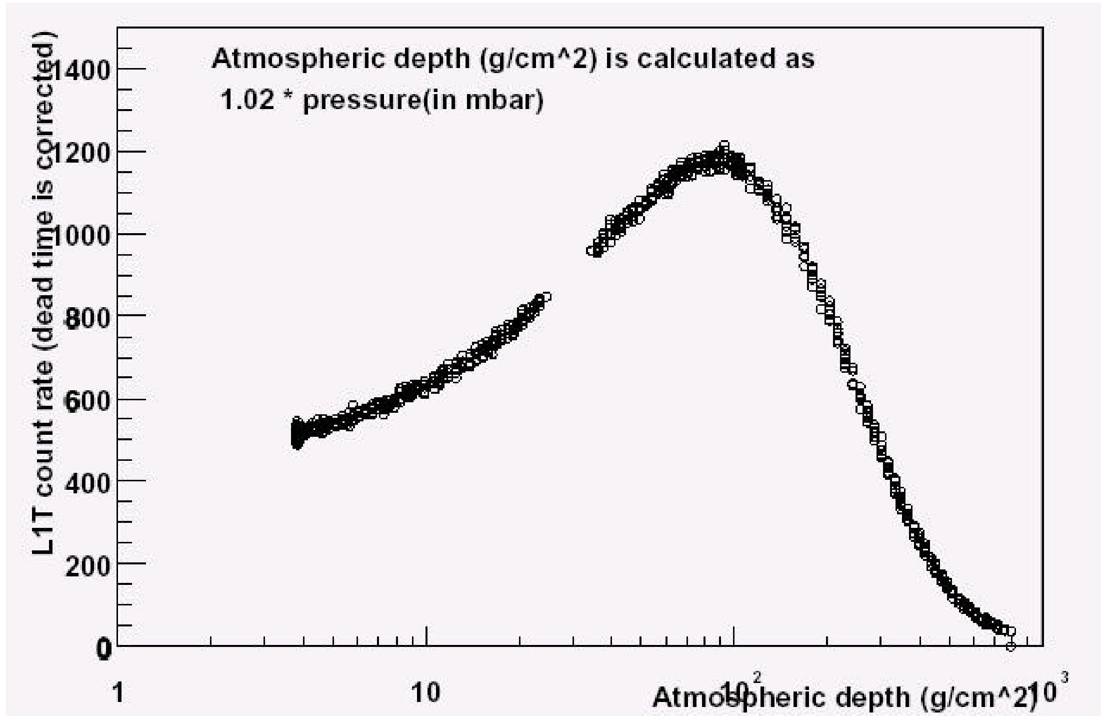
16 Calorimeter Modules + 2 spares

1 Flight Anticoincidence Detector

Data Acquisition Electronics + Flight Software

Flight and Operation:
Launch on August 4, 2001

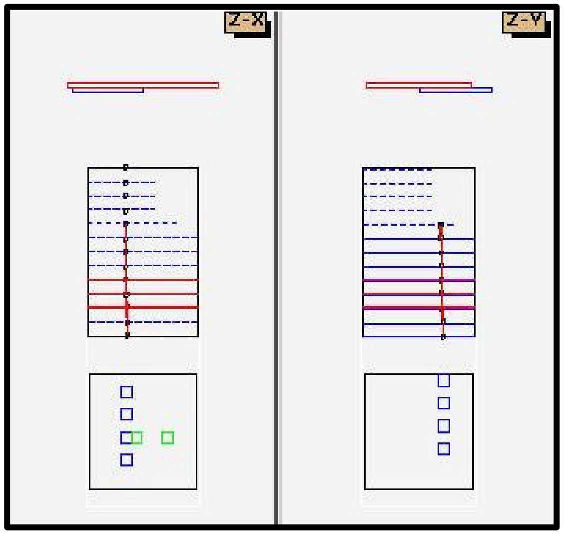
The balloon reached an altitude of 38 km, with a float time of 3 hours.

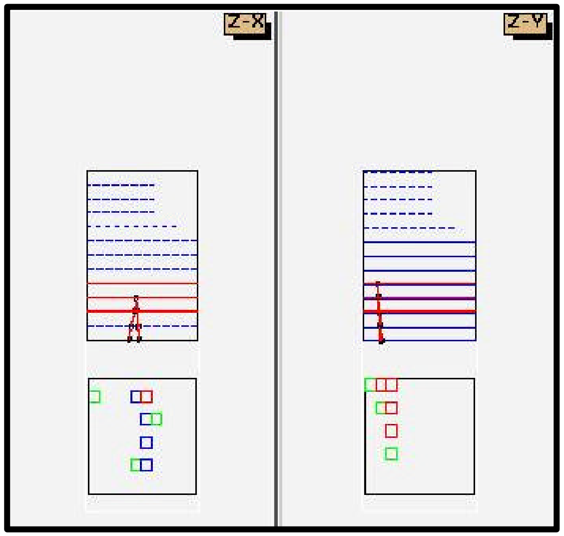


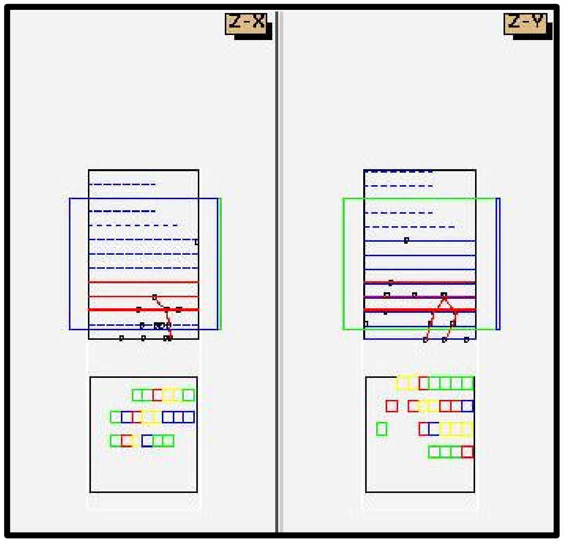
First results (real-time data): trigger rate as a function of atmospheric depth. The trigger rate never exceeded 1.5 KHz, well below the BFEM capability of 6 KHz.

All Subsystems Performed Properly

Results: Reconstruction of Events







Charged particle event:

The track passes through the ACD (top), the tracker, and the calorimeter.

Note: Tracker has no Si strips in the upper right corner

Gamma-ray event:

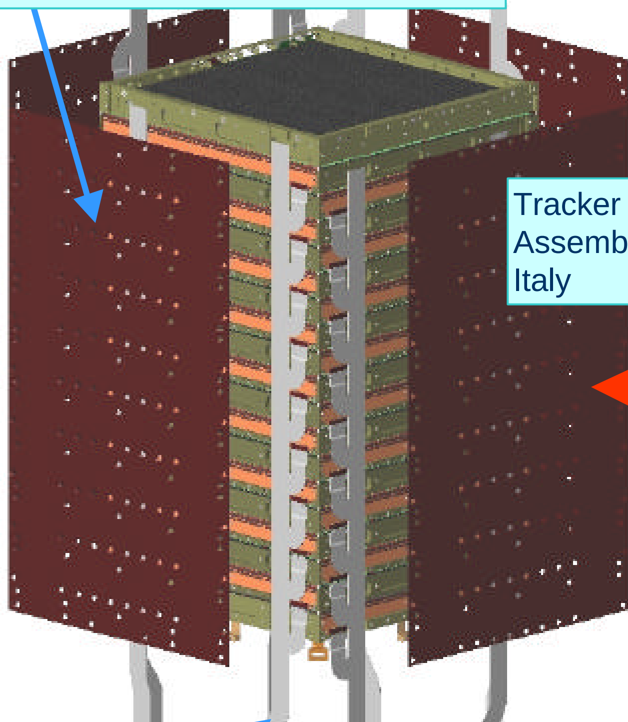
Two tracks are seen in the tracker and calorimeter. Pattern recognition of an inverted "V" will allow us to selected gamma-rays from cosmic-ray background.

Complex event:

Particle and gamma –ray splashes deposit energy in ACD, Tracker, and Calorimeter.

Tracker Production Overview

Module Structure (walls, flexures, thermal-gasket, fasteners)
Engineering: SLAC, Hytec
Procurement: SLAC

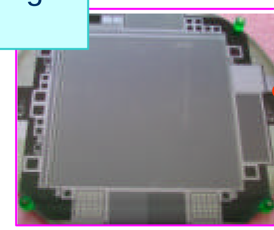


Tracker Module Assembly and Test
Italy

18

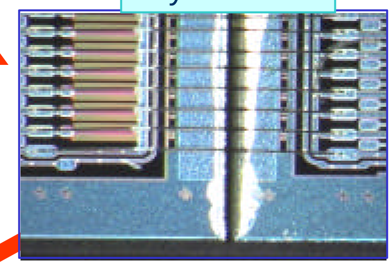
Cable Plant
UCSC

SSD Procurement, Testing
Japan, Italy, SLAC

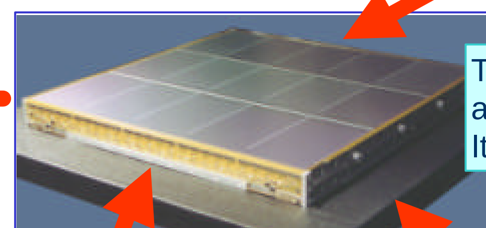


10,368

SSD Ladder Assembly
Italy



2592



Tray Assembly and Test
Italy

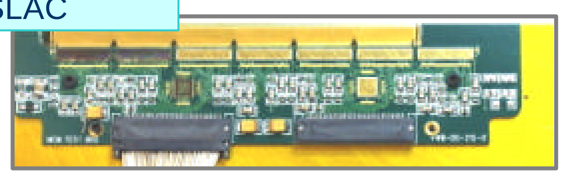
342

342

Composite Panel & Converters
Engineering:
SLAC, Hytec, and Italy
Procurement: Italy

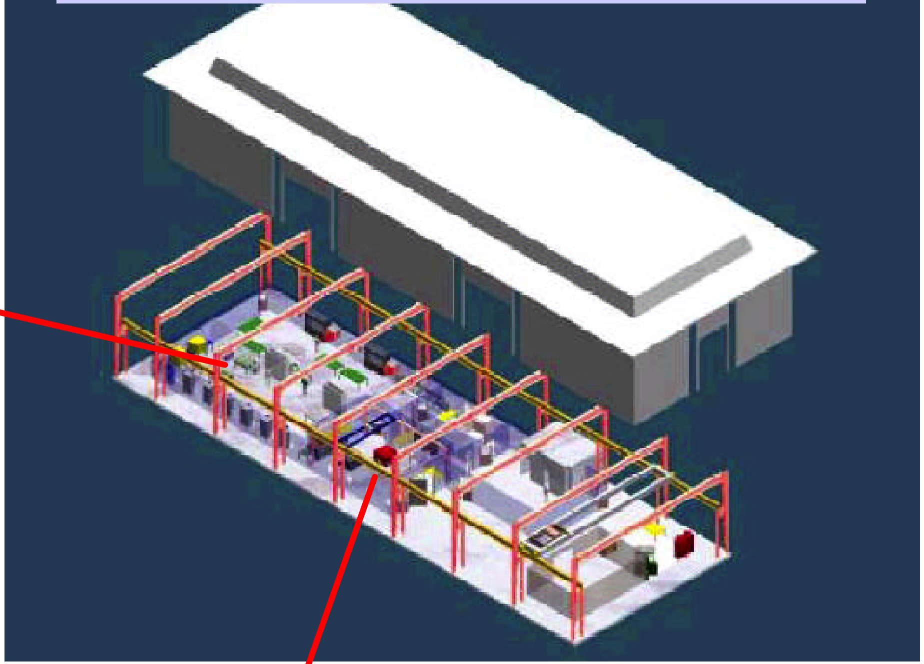
Electronics Design, Fabrication & Test
UCSC, SLAC

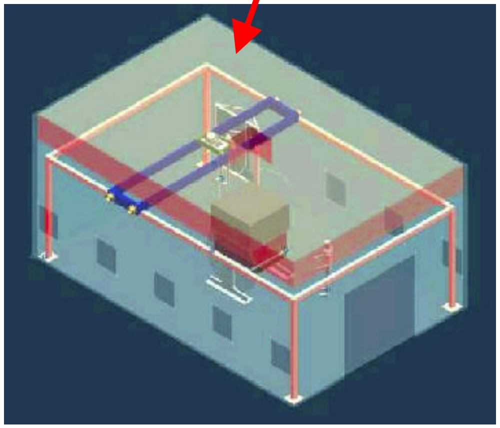
648



WBS 4.1.9: LAT I&T

Subsystem Manager: E. Bloom, SLAC



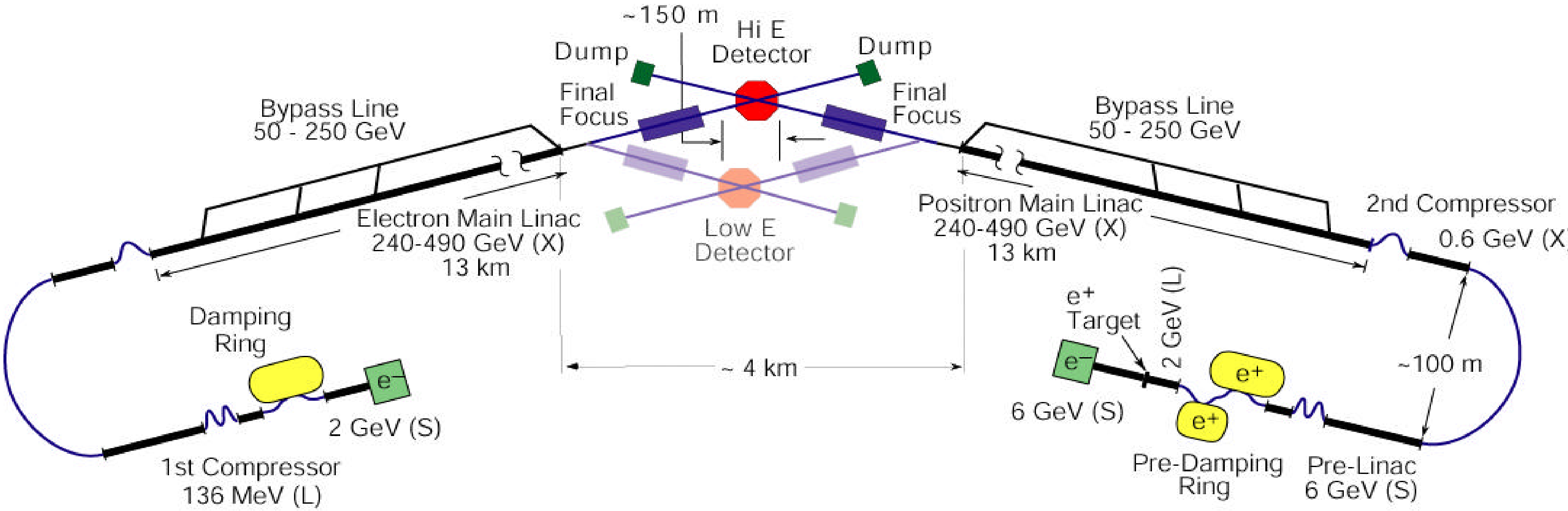


Renovated Light-Assembly Building I&T Facility

Next Linear Collider

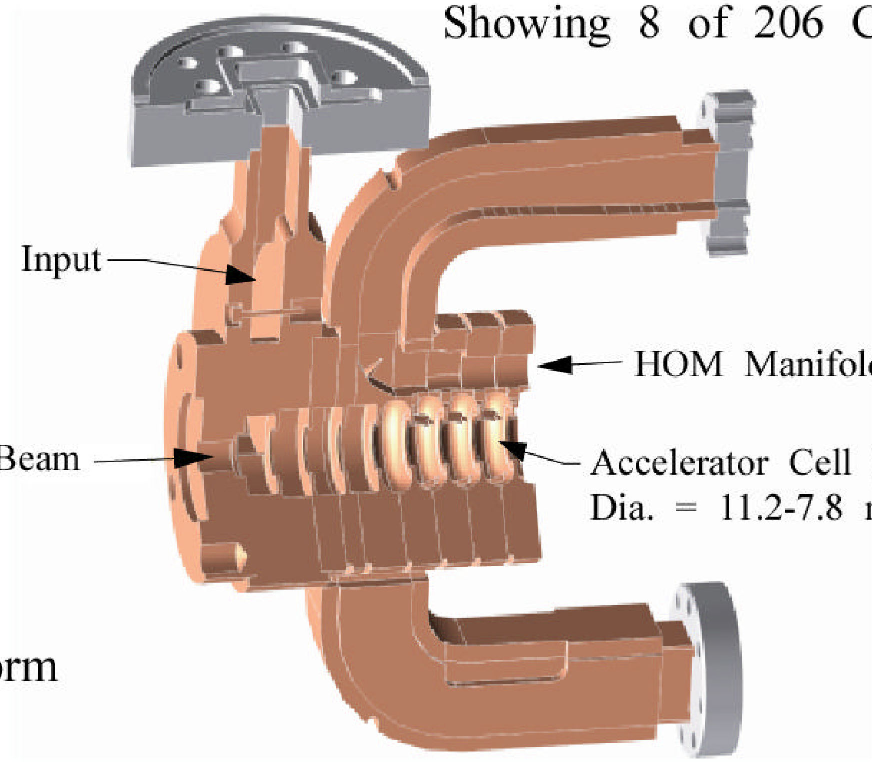
- National NLC R&D Collaboration continues to make excellent progress
  - We welcome Brookhaven National Laboratory into the existing SLAC, FNAL, LBNL, LLNL Collaboration
- R&D progress in many areas – some of which you will hear in the FNAL presentations. Collaboration has established:
  - Major progress on eliminating structure breakdown problem
  - A set of tests to demonstrate full RF power distribution capabilities
- SLAC is actively participating in the emerging national effort focused on enhanced participation in machine and detector R&D
  - We have provided a list (the "Himel list") of machine R&D tasks for community involvement
  - We have had representatives at the FNAL and Cornell meetings
  - SLAC's outreach meeting will be May 31st

Layout of the NLC



NLC/JLC Rounded Damped-Detuned Structure (RDDS)

RDDS Cutaway View Showing 8 of 206 Cells



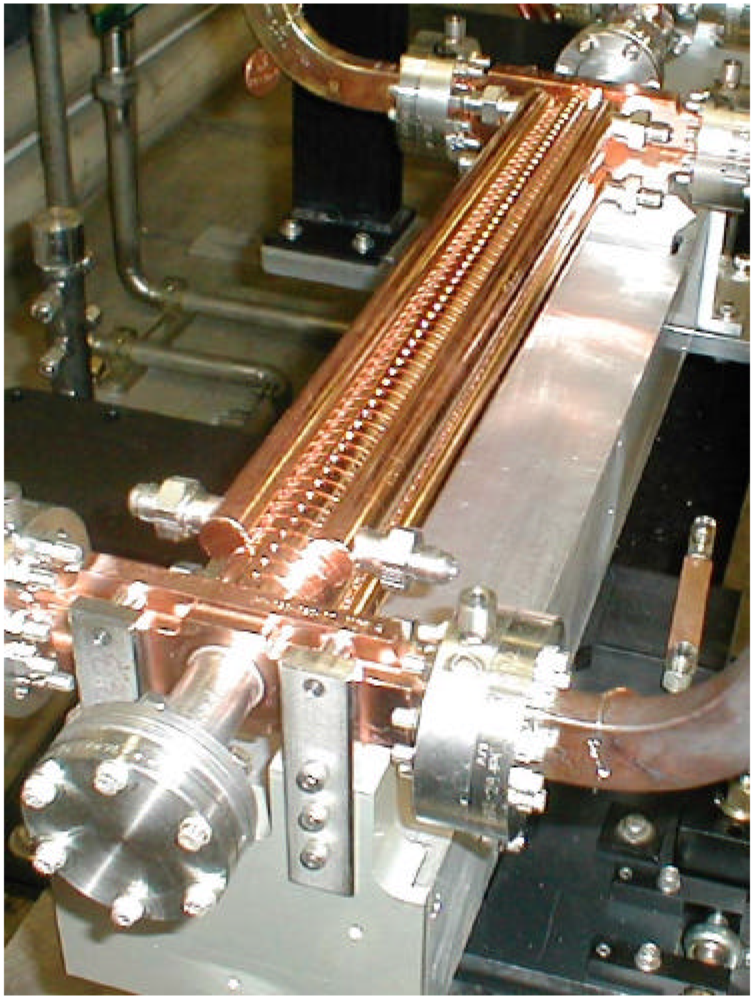
- Made with Class 1 OFE Copper.
- Cells are Precision Machined (Few µm Tolerances) and Diffusion Bonded to Form Structures.
- 1.8 m Length Chosen so Fill Time ≈ Attenuation Time ≈ 100 ns.
- Operated at 45 °C with Water Cooling. RF Losses are about 3 kW/m.
- RF Ramped During Fill to Compensate Beam Loading (21%). In Steady State, 50% of the 170 MW Input Power goes into the Beam.

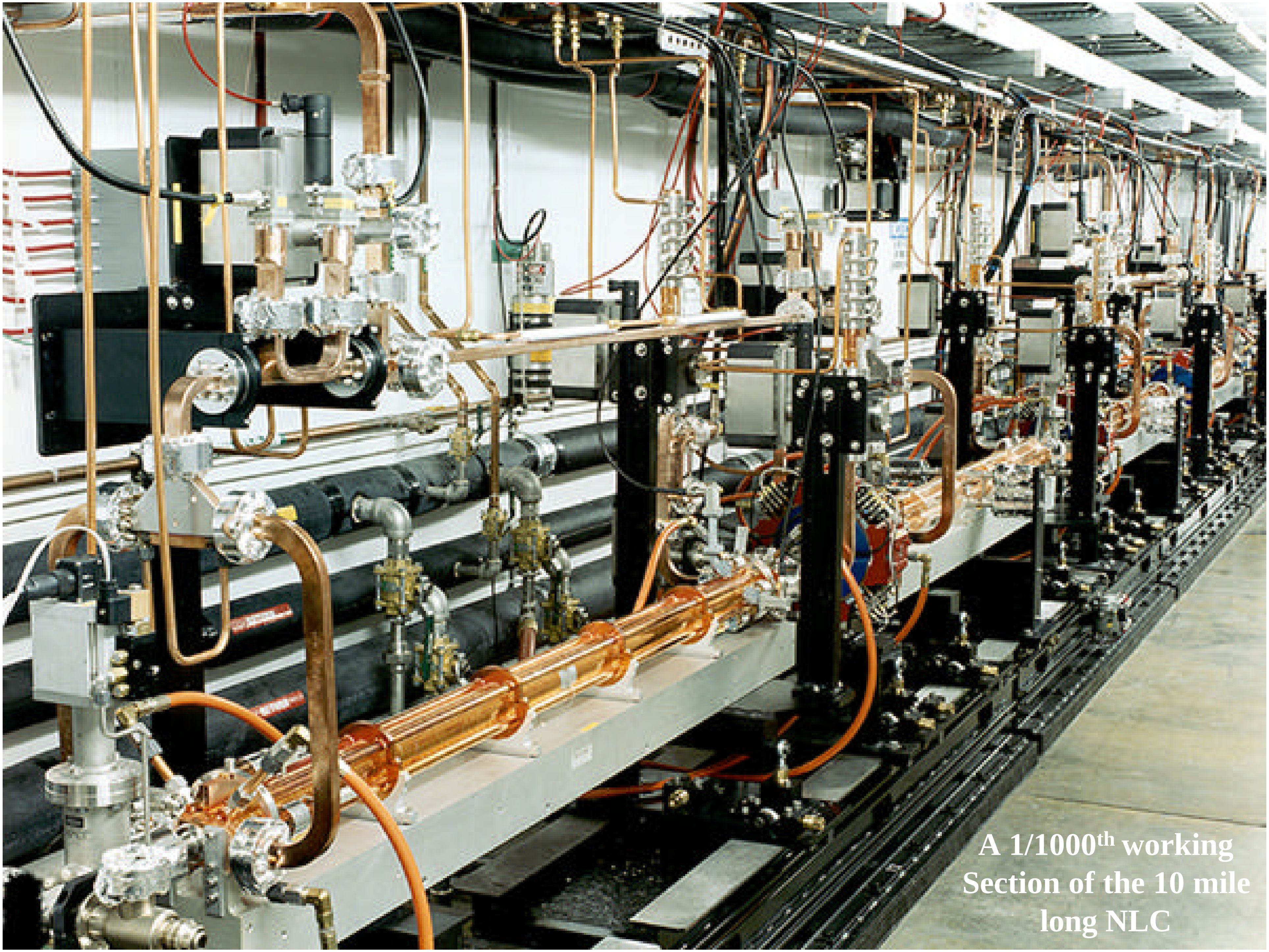
Two RDDS Cells

Low Group Velocity Traveling-Wave Structures

- Best performance thus far with 3% c initial group velocity structures.
- One was processed to 86 MV/m, after which breakdown rate at 70 MV/m was about 1 in 200,000 pulses, dominated by input/output coupler events. Rate at 65 MV/m was about 10 times smaller, which would be acceptable for the NLC.
- Damage level small during processing (1/2° phase shift) – tolerable for NLC even if increased at same rate after processing, which has not been observed.
- Tests of 3% c and 5% c initial group velocity structures with improved couplers, NLC-acceptable iris radii and wakefield detuning are scheduled this year – versions with wakefield damping will be ready in early 2003.

T53VG3: 53 cm long, 60 cells





A 1/1000th working Section of the 10 mile long NLC

NLC Linac RF Unit

Low Level RF System

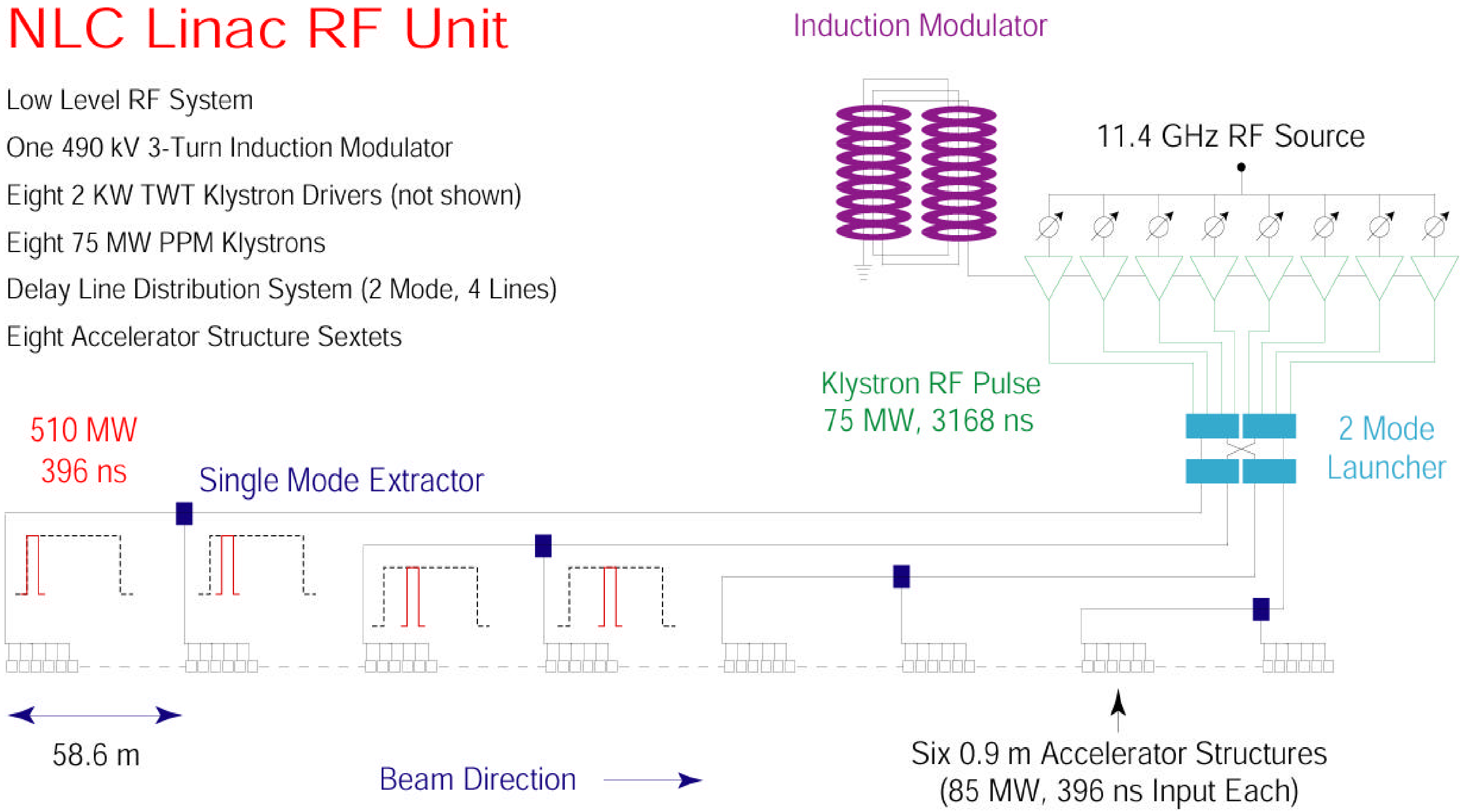
One 490 kV 3-Turn Induction Modulator

Eight 2 KW TWT Klystron Drivers (not shown)

Eight 75 MW PPM Klystrons

Delay Line Distribution System (2 Mode, 4 Lines)

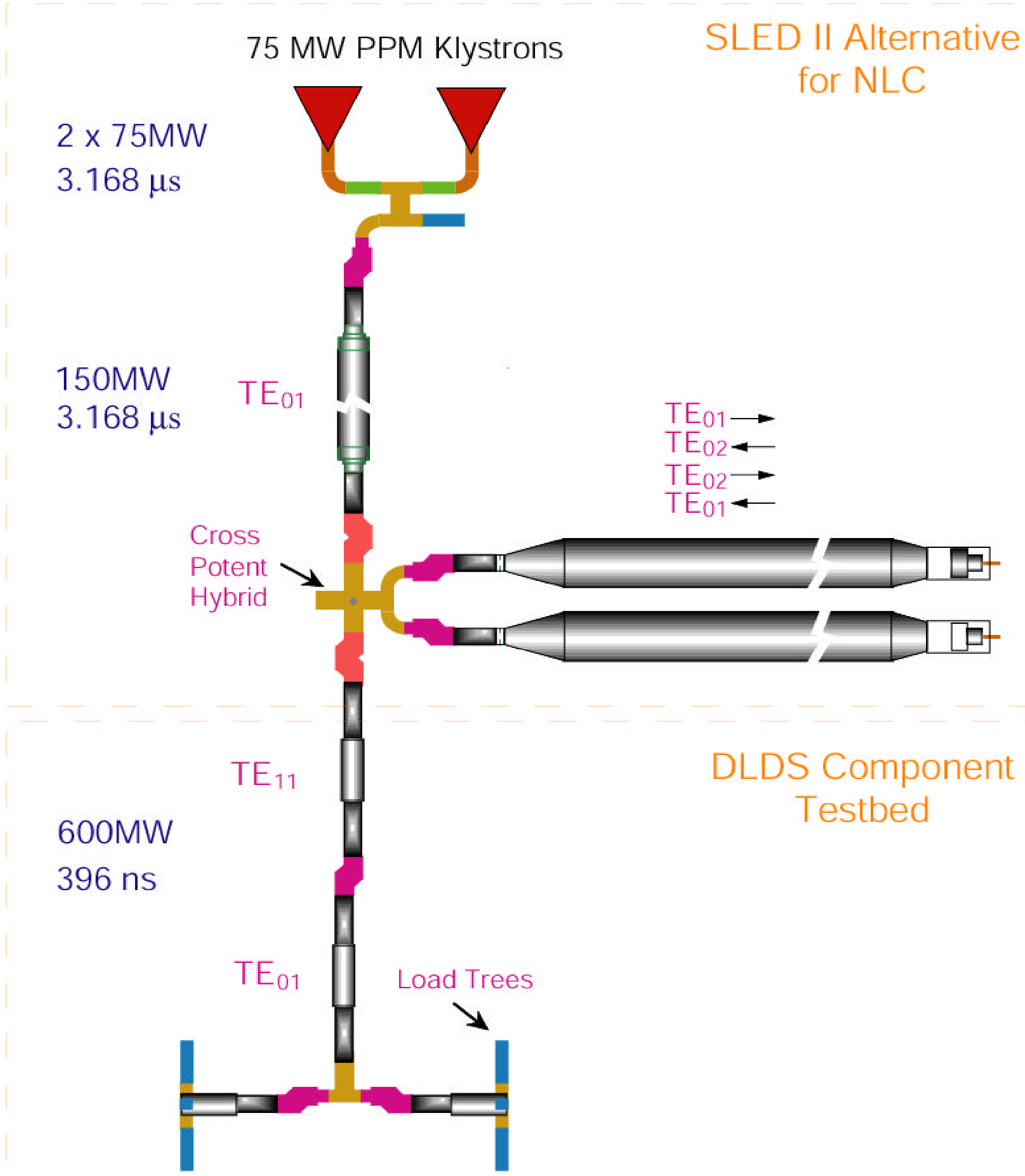
Eight Accelerator Structure Sextets



Eight-Pack Test
(Phase I)

Multi-Moded SLED II

Begin Testing
at End of 2002



Eight-Pack Test (Phase II)

Low Level RF System

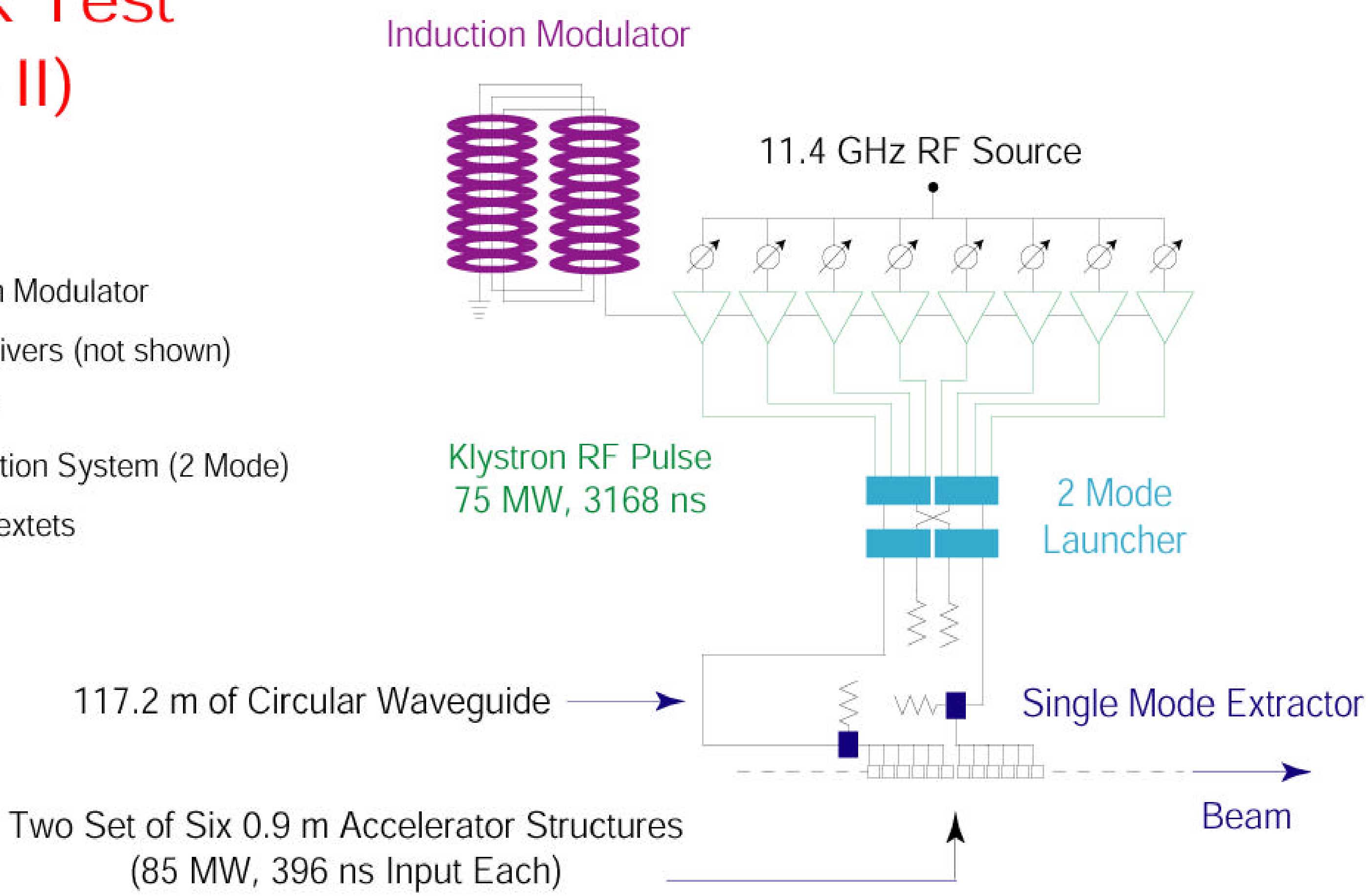
One 490 kV 3-Turn Induction Modulator

Eight 2 KW TWT Klystron Drivers (not shown)

Eight 75 MW PPM Klystrons

Reduced Delay Line Distribution System (2 Mode)

Two Accelerator Structure Sextets



Workshop at SLAC on Linear Collider R&D Opportunities

May 31, 2002

Goal

The overall goal is to facilitate the university community involvement in LC detector and accelerator R&D. This should build on the work already done at FNAL and Cornell. The following sub-goals will help accomplish this:

- Discuss the mechanisms to organize this involvement on a national (and international) level to foster collaboration and avoid duplication of efforts
- Provide lists and descriptions of concrete problems that need development work. These lists should be made before the meeting and presented at the meeting
- Aid the formation of the necessary communications links and smaller groups to facilitate the writing of proposals and starting of R&D efforts

Rough Draft Program

9:00 Welcome. Goals of the Workshop.

9:10 What's the Mechanism for Submitting, Reviewing and Funding Proposals? The View from the LC Steering Committee - Dorfan

9:30 Discussion

9:50 Accelerator status and R&D Issues--Where Can We Help?

10:50 Coffee

11:20 Experiences Working On Machine R&D - Burrows

11:35 Why the LC Detector Can't Be Built Today--Outstanding R&D Problems and the International R&D List

12:35 Lunch

1:30 Parallel sessions

3:30 Coffee

3:45 Summary of parallel sessions by the working group leaders

4:30 Coordinating Efforts Between the Regions - The Role of the North American Working Group

5:00 Panel Discussion and Open Questions

5:30 Wine and Cheese

There will be 5 parallel sessions:

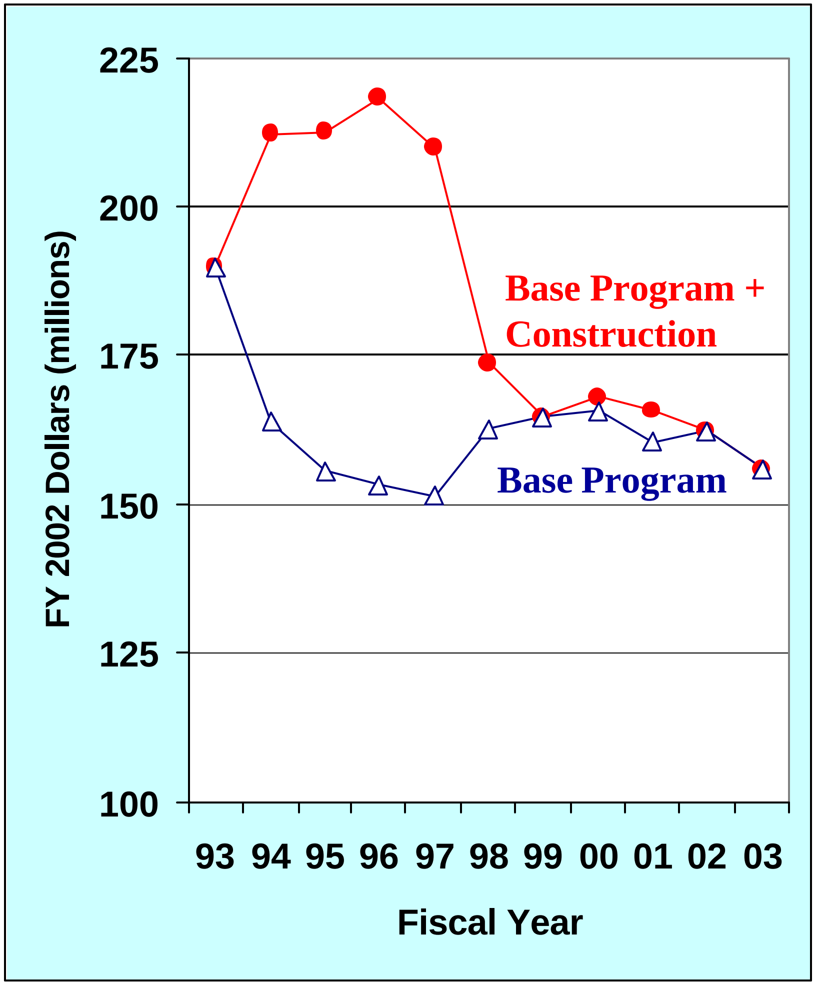
1. Vertex detectors
2. Tracking detectors
3. Calorimetry
4. Machine detector interface including energy, luminosity and polarization measurement
5. Accelerator R&D

At each section there will be 1-2 talks giving status and lists and then discussion leading to ideas of who wants to work on what with whom.

Tight Budgets

- HEP budgets have been excessively tight the past 5 years. In a world of 4% per year inflation, we have had to accommodate the HEP Program to non-inflation corrected budgets
- SLAC has been well treated within those constraints, but the impact on the laboratory has nonetheless been major:
  - We are very significantly understaffed in all our highest priority programs
  - Costs, albeit modest at ~ $4M/year, for the upgrade of *B* Factory come from within the flat-flat envelope. Likewise for increased power costs
  - Critical maintenance on aging infrastructure is constantly deferred

SLAC HEP Funding
(FY2002 Dollars)



* For comparability over the years, the following two adjustments have been made:
1) Waste Management funding (~$2.7 M per year), transferred from EM since FY98, has been excluded
2) Security funding (~$1.4 M per year), directly funded from SC since FY01, has been added

FY	93	94	95	96	97	98	99	00	01	02	03
Base Program *	189.8	164.0	155.7	153.3	151.5	162.8	164.7	165.6	160.4	162.2	156.0
Base Prog. + Construction *	189.8	212.0	212.4	218.3	209.8	173.8	164.7	167.8	165.8	162.2	156.0

SLAC FY03 Budget

- The proposed FY03 budget for SLAC is $675K below our FY02 funding level. NLC funding remains fixed at its FY02 level of $16.2M.

  At this level of funding, we must accommodate:

  - Inflation : $5M
  - *B* Factory upgrade costs : $4M
  - Increased power costs : $2M

- At this level, none of the highest priority level programs can be insulated from significant cuts
- We have not yet decided how we will accommodate to the budget stresses in FY03